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SUMMARY OF THE 1933 SITUATION RELATIVE TO
THE YELLOWSTONE PARK BARK-BEETLE CONTROL PROJECT
WITH RECOMMENDATIONS FOR CONTROL

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INTRODUCTION

The severe infestation of the mountain pine beetle in the lodgepole pine and whitebark pine stands of the Yellowstone National Park and adjacent National Forests has been designated "the Yellowstone Park bark-beetle control project." This designation seems a logical one, as previous control operations within the general area have had as one of their objectives the preservation of the scenic timber stands of the Yellowstone National Park. Though control measures had been conducted within these areas for a number of years, the project was discontinued in 1931, as the chances of success no longer seemed to justify the large expenditures necessary for control, with the understanding that the outbreak was to be carefully followed, and if at any future date the institution of control appeared more feasible necessary action was to be taken. The discovery in June 1933 of the destruction of a large per cent of the overwintering broods of the mountain pine beetle within the Beaverhead National Forest as a result of the severe temperatures of the past winter seemed to indicate such a "break" had occurred, making the successful reopening of the entire project a possibility. With this possibility surveys were conducted on all areas during September and October, and it is the purpose of the writer to present in this report a complete summary of all these data and to offer his conclusions as to the feasibility of control. As the reopening of this project would involve a large expenditure of public funds, as well as the institution of control over a tremendous acreage, this report has been prepared in detail in order to assist the reader to thoroughly visualize the entire situation.

BARK-BEETLE FLIGHTS

This project rests heavily upon the mooted question of bark-beetle flights, or if one prefers, the spread of epidemic infestations. The thought is often advanced that all bark-beetle outbreaks originate within the area infested, and aside from the short flights necessary to reach a new host there is no spread of these infestations. The writer feels that though this is what undoubtedly happens with many infestations there are exceptions to such a rule. Officers of the Bureau of Entomology have satisfied themselves to a point where they sincerely believe that epidemics of the mountain pine beetle in lodgepole pine have spread over large areas as a result of both long and short flights. This position is not a mere principle, or theory, but is based upon a study of existing epidemics over a period of years. Very positive evidence is available as to the spread of infestations from heavily infested areas into clean drainages adjacent, in much the same manner as a fire would sweep into such regions. First a few red-tops occur where the preceding year none were to be seen. During the next two or three years, as the heavy infestation approaches the newly infested area, the spots of red-tops increase in size and number until the entire region is engulfed by the heavy infestation, and becomes a part of it. Of course, one can not actually prove the occurrence of a flight or migration of bark beetles from one area to another, but a logical deduction from the many repeated demonstrations would seem to leave no other conclusion to be drawn. Though firmly convinced that such spreads have occurred, forecasts of others can not be made, nor can it be said as to how far, or in what

direction, the insects from a definite area will fly, if such a flight does occur. However, regardless of this uncertainty, mountain pine beetle outbreaks which are allowed to develop into heavy blocks of infestation must be considered as constituting a serious potential menace to timber stands not only immediately adjacent but some distance removed.

HISTORY OF THE INFESTATION

An outbreak of the mountain pine beetle in the lodgepole pine stands of the Big Hole Basin, Beaverhead National Forest, was recorded in 1911. Control measures were instituted in 1912, and again in 1913, and a total of 25,000 treated by peeling the lower portion of the bole. Apparently this work was very successful, or at least the outbreak subsided, as no further losses were recorded from this area until 1926. Furthermore, when in 1926 control measures were again instituted within the same area as a means of checking the spreading Bitterroot outbreak, there were no indications of depredation following the 1913 project, though the trees treated at that time were still standing as mute evidence of the early outbreak. This outbreak was apparently an instance of an infestation which had developed locally, and which was brought under control before much headway had been gained.

During the summer of 1924 an extensive survey conducted by the Bureau of Entomology showed a heavy infestation on the head of the east fork of the Bitterroot^{Oct} River on the Bitterroot Forest. In the spring of 1925 a few thousand dollars were spent in treating the trees in front

of an imaginary line drawn across the apparent head of this infestation, with no recognition of the ability of these insects to fly even short distances. As can be imagined, this operation proved futile, having no visible effect upon the infestation, and the following season, 1926, the infestation swept over this line of defense, extending the so-called "front of the infestation" a few miles further on.

During the summer of 1925 a survey showed that there were some rather large groups of 1925-attacked trees on the west side of the Big Hole Basin, Beaverhead Forest, where in 1925 there were only a few small spots and single trees scattered throughout the area. With the hopes that this infestation was of local origin, control measures were instituted in the spring of 1926 for the treatment of the infested trees within the Big Hole Basin, with the idea of preventing the development of a serious outbreak, which would endanger the timber stands further to the south. During this project a very thorough clean-up was made of the infested area, and approximately 12,000 trees were treated. Coincident with the 1926 Big Hole Basin project another attempt was made to check the spread of the Bitterroot outbreak by again treating the infested trees within a zone across the front of the infestation. Though some hope was held for the success of the Big Hole project, with the expectation that the Continental Divide would at least act as a partial barrier to any spread which might occur from the Bitterroot, very little chance of success was offered for the work on the Bitterroot.

A survey conducted during the summer of 1926 revealed the fallacy of continuing the Bitterroot project, as the insects had again swept across the treated defense zone in tremendous numbers. This survey also

showed the thoroughly treated area within the Big Hole to be so heavily infested that the source of supply could not have originated within the area, with the nearest adjacent infestation being the Bitterroot epidemic. In conducting the 1926 survey the maximum potential spread of the Bitterroot infestation was underestimated, for not only was the treated area on the west side of the Basin reinfested by insects which can only be explained as having come from the Bitterroot, but the timber stands on the east side of the Basin were rather heavily infested as well. It is also believed that some infestation occurred from this source in 1925, as there were a few red-topped 1925-attacked trees to be seen during the 1926 survey, which was limited to a red-top survey of these areas.

Still hoping that the Big Hole Basin could be held against the potential spread of myriads of beetles from the Bitterroot, a much larger area on the west side of the Big Hole Basin was again thoroughly covered by spring control in 1927. Again the results of the subsequent survey following this project were discouraging, as the reinfestation of the control areas was not only greater than the amount treated but all portions of the Basin were found to be heavily infested. In some of these newly discovered areas of infestation there were a few 1926 attacks, with a very few of 1925 origin; however, with many of the large groups of infested trees there were no previous attacks in evidence.

At this time a new element of danger to the success of this project was recognized. With its source an item of conjecture, a severe epidemic of the mountain pine beetle was found throughout the lodgepole pine stands of the Salmon and Challis National Forests. The Salmon

Forest borders the Beaverhead Forest, and the large blocks of infested timber could only be considered as constituting a new source of reinfestation to some of the areas being covered by control within the Big Hole Basin. In fact, there was no reason to believe that these centers of infestation had not already contributed to the scattered infestation which was present in the southern portion of the Big Hole Basin in 1927.

The continuation of the Big Hole Basin project was a questionable procedure for the spring of 1928. However, as the devastation which would occur if the outbreak could not be checked was easy to foresee, and in consideration of the scenic and commercial values at stake, control was again instituted with no great hope of success. Disappointment again reigned, as the reinfestation which occurred during the summer of 1928 fully demonstrated the folly of attempting to continue this project as planned. This position can best be explained by the fact that in 1923 there were 60,000 acres covered by control at a cost of \$89,000. The 1923 reinfestation of this area was so severe that at least \$350,000 would have been required for control in 1929, and in addition to this area it was shown by the survey that there were some 500,000 additional acres supporting a light infestation that would need to be considered in all future plans of control. Though further work in the Big Hole Basin was discontinued, the seriousness of the situation was fully appreciated, and it was recommended that every effort be made to prevent the infestation from spreading into the old Madison Forest, which was separated from the Beaverhead by some rather wide timberless areas. This plan of attack called for an annual survey of the areas

to the south and east of this potential barrier, with the prompt treatment of all infested trees.

At this point the writer begs the privilege of breaking into this history to mention the value of adequate surveys, and to urge that they be considered as a part of all insect-control projects. The Big Hole survey of 1928 was the first adequate examination of this project, and its worth has been proved many times over. Without the data secured from this survey it is possible that the project might have been continued, with large sums of money being foolishly spent in attempting to stem the spread of insects, which had already crossed the so-called "barriers" and were established miles away. The institution of a control project without complete information as to the status of the infestation within adjacent areas, though sometimes necessary because of the time element involved, should always be avoided whenever possible. However, if necessary to institute a project without such data, its continuation on such a basis can not be justified on any grounds, and inevitably leads to useless expenditures of public funds.

No further work was directed against the Beaverhead infestation until in 1930 some small spots of infested trees were found scattered throughout the western portion of the old Madison Forest. At the same time it was discovered that the timbered area known as Sheep Creek Canyon, which lies between the Beaverhead and the Madison, was rather heavily infested. In the spring of 1931 another effort was made to check the southern spread of this outbreak, and all of the infested areas within the Madison as well as the Sheep Creek Canyon were thoroughly treated.

To complete this picture it is necessary to return to the year 1923, as at that time infestations of the mountain pine beetle were found in the lodgepole pine stand of the Targhee Forest to the south of the Beaverhead. The Targhee Forest borders the Yellowstone Park to the southwest, which made its infestation a serious potential menace to the scenic forests of Yellowstone. Control measures were instituted in the spring of 1923 on the Targhee, and all known infestations were treated. However, a survey conducted during the summer showed that the outbreak was far more widespread than had been anticipated, and was also present within the Teton, Wyoming, Caribou, and Cache National Forests. In 1929 control measures were instituted in these forests, and again all known infested areas were treated. Disappointment was again encountered, for the subsequent survey disclosed a marked increase in the 1929 infestation in all of these forests, with the exception of the Targhee, where the number of infested trees remained about the same as the number previously treated. A few new areas of infestation were also disclosed in all of the forests as a result of this survey.

The determined effort to check this outbreak was continued in 1930, and control measures were again conducted on all of these forests and once more all known infested areas were treated. Surveys of these forests conducted during the fall of 1930 were also disappointing, for though reductions occurred in most of the treated units, new areas of infestation were discovered in all forests. To add to the general discouragement a light infestation was also discovered in the southwest corner of the Yellowstone National Park, for which protection was especially desired.

In 1931 a program of control, more intensive than heretofore undertaken, was again instituted on all five of the National Forests as well as the Yellowstone Park, and every effort made to secure a thorough cleanup of all infested areas, in the hopes that success would follow the effort. Stress was placed upon the thorough treatment and the importance of locating all infested trees within each area treated. It will be recalled that at this time a similar effort was being made to treat all of the infested trees on the Madison Forest, which borders the Targhee National Forest on the north.

The source of the infestation discovered on the Targhee in 1928, and subsequently on the Teton, Wyoming, Caribou and Cache Forests in 1929, is unknown. Outbreaks of the mountain pine beetle develop locally, and it is possible that the outbreaks on these five forests originated locally from normal or endemic infestations. However, with our present understanding of the ability of the mountain pine beetle to fly or, if preferred, to be carried by strong air currents, an influx of insects from the heavily infested areas to the northwest is not an impossibility. The writer refrains from expressing an opinion upon this question, except to say that both solutions are possible. It is a matter than can not be decided, so need not be discussed further.

However, regardless of the original inception of these outbreaks, the source of the reinfestation on the treated areas which has occurred annually has a direct bearing upon any future consideration of this project. Such reinfestation must either have originated from infested bark surface left untreated within the different control units or from flights of insects from untreated areas. Untreated bark surface could

have existed in trees missed during the operation, and through the inadequate treatment of infested trees. Flights of insects would of a necessity have come from the severe epidemics of this insect to the north, or from some untreated areas adjacent to the reinfested control units, the presence of which was unknown. In an effort to throw some light upon this mooted question, the 1931 control operations were instituted on a basis of a 100 per cent clean-up, in an effort to eliminate one of these sources of supply. The occurrence of a heavy reinfestation following such a clean-up would indicate that the insects were flying into the control units from adjacent areas.

Following the 1931 operation, very thorough surveys of all forests involved were conducted, and the results secured were discouraging. Infested areas were found on the Gallatin and throughout the Yellowstone, with marked increases in the infestation on the old Madison and Targhee Forests but with little change in the status of the other areas. As a result of this situation the Yellowstone Park bark-beetle control project was discontinued, and no further work conducted on the Madison, Targhee, and Yellowstone, as the chances of success did not seem to justify the necessary expenditure. The seriousness of discontinuing this project was fully recognized, and it was understood that the general situation was to be carefully followed, and if at any future time control appeared more feasible the necessary action was to be taken.

Surveys were again conducted in 1932, and as the data secured did not indicate the occurrence of any break in the infestation, no action was taken, except upon the Greys River area on the Wyoming, and

the Cache National Forest, which were again covered by control in the spring of 1933. This in brief is the history of the Yellowstone Park control project up to 1933. The 1933 situation will be presented under "Present Status of Infestation."

PRESENT STATUS OF INFESTATION

In depicting the 1933 status of the mountain pine beetle infestation the forests involved in this project will be treated separately, and in sufficient detail to permit the reader to draw his own conclusions. Though perhaps there is no entomological separation of the different forests of this project, there is an administrative division which necessitates such action and permits these forests to be used as project units.

Before discussing the separate forests of Region One it is well to recall for a moment some of the early control activities. The Big Hole Basin project was instituted in 1926 in an attempt to prevent the southern spread of the Montana epidemic, and discontinued in 1929 as being impracticable. With the cessation of the Big Hole Basin project a new plan of control was adopted whereby the timberless region between the Beaverhead and old Madison Forest, which is now a part of the Beaverhead, could be utilized as a possible barrier to the additional spread of the insects. It was believed that this plan, which called for an annual survey of the timbered areas to the south and east of this potential barrier with the prompt treatment of all infested trees, offered the best chance of protecting the valuable commercial and aesthetic timber stands in the path of this outbreak.

Beaverhead National Forest

Year of attack	Aores infested	Trees per acre	Number infested trees	Remarks
1925	17,920	.294	5,271	Trees treated 1926
1926	18,588	.937	17,418	Trees treated 1927
1927	299,520	.183	55,045	Trees treated 1928
1928	1,341,860	.239	321,372	No control
1929	1,341,860	1.553	2,084,123	" "
1930	1,341,860	2.858	3,835,958	" "
1931	1,341,860	11.478	15,402,520	" "
1932	1,341,860	13.105	17,536,171	" "
1933	1,341,860	.682	915,597	" "

During the three seasons of control, 1926-1928, the intensity of the infestation within the Big Hole Basin was held to a fairly low level, though there were marked increases in the infested areas. Following the close of the operation, the outbreak increased in severity until in 1932 there were 17,536,171 newly attacked trees. In 1933 a marked reduction in the infestation occurred, which was foreseen early in June, when a heavy mortality to the overwintering broods of the mountain pine beetle was discovered. Though undoubtedly this extreme reduction in the infestation on the Beaverhead was largely due to the exceedingly low temperatures of the past winter, a slight normal reduction had been expected, as the maximum timber loss for the forest had been reached. The relation of the Beaverhead Forest to the Yellowstone project has only been considered in the light of a potential

source of reinfestation. With this marked decrease in the volume of infestation, this unit, for the present at least, need no longer be considered as endangering the success of control which may be instituted within the areas to the south.

Sheep Canyon Area (Public Domain)

Year of attack	: Acres infested	: Infested : trees per acre	: Number : infested : trees	: Remarks
1930	: 2,3457	: 1,296	: 3,045	(Treated 1931. Timbered acreage only. Not treated. Acreage includes total area surveyed. 4000 acres used to compute trees per acre.)
1931	: 23,680	: 5.795	: 23,183	: Ditto
1932	: 23,680	: 37.750	: 151,000	: Ditto
1933	: 23,680	: 3.714	: 14,358	: Ditto

Control measures were instituted on this area in the spring of 1931 in accordance with the plan of control adopted for checking the spread of the Beaverhead infestation into the old Madison Forest. Following the treatment of the 1930-attacked trees the infestation increased some 665% in 1931, 561% in 1932, with a decrease of 90% in 1933. This decrease in the infestation, though somewhat lower, is comparable to that which occurred on the Beaverhead, and permits the same conclusions as to winter kill to be drawn. Regardless of this reduction there is still a rather heavy infestation, with 5.7 trees per acre, on this area, which will no doubt rebuild if sufficient host material is available.

Madison National Forest

Year	:		:	Infested	:	Number	:
of	:	Acres	:	trees	:	infested	:
attack	:	infested	:	per acre	:	trees	:
							Remarks
1930	:	13,889	:	.203	:	2,825	:
	:		:		:		(Treated 1931. Timbered acreage only. Not treated. Acreage includes total area surveyed. 18,000 acres used to compute trees per acre.
1931	:	45,780	:	.387	:	6,975	:
1932	:	45,780	:	1.073	:	19,317	:
1933	:	45,780	:	.416	:	7,504	:

The areas on the Madison Forest treated in 1931 were included in the plan of control for the checking of the spread of the Beaverhead infestation.

From the above data it will be seen that there was also a marked reduction in the 1933 infestation of this area. Though this reduction, which amounted to 61%, was not as great as the Sheep Creek Canyon or Beaverhead Forest, it does indicate an abnormal brood mortality due undoubtedly to the same agency.

Gallatin National Forest

Year	:		:	Infested	:	Number	:
of	:	Acres	:	trees	:	infested	:
attack	:	infested	:	per acre	:	trees	:
							Remarks
1931	:	62,720	:	.154	:	9,676	:
1932	:	114,660	:	.151	:	17,383	:
1933	:	141,440	:	.134	:	18,956	:

This forest was not considered as a part of the Yellowstone

project until 1931, when a complete picture of the infestation surrounding the Yellowstone was desired. No control work has been conducted, and the infestation remains at apparently the same level, with only one or two small areas which appear to be alarming at this time. However, we know that an infestation does exist, which must be considered a potential danger in planning for the protection of the Yellowstone. The acreages given above are those on which a somewhat concentrated infestation occurs. There are some 1,038,400 additional acres on this forest, on which in 1933 there were some 26,000 newly attacked trees, or an average of .025 trees per acre.

Targhee National Forest

Year	:	Infested	:	Number	:
of	Acre	tree	:	infested	:
attack	infested	per acre	:	tree	Remarks
1927	: 5,000	: .550	:	2,752	: Treated spring 1928
1928	: 14,800	: 2.108	:	31,205	: Treated spring 1929
1929	: 67,948	: .442	:	30,064	: Treated spring 1930
1930	: 102,370	: .349	:	35,987	: (3,671 treated fall 1930 (32,316 treated spring 1931)
1931	: 480,427	: .249	:	119,874	: Not treated
1932	: 494,587	: .345	:	170,862	: " "
1933	: 464,284	: .653	:	303,189	: " "

Though during the last three years of control there was no great increase in the number of infested trees treated, a steady increase in the infested acreage occurred each year until in 1931 the entire forest was included in the survey and found to be infested. Following the

cessation of control the infestation increased until at this time there are over three hundred thousand infested trees distributed throughout the northern portion of the forest, indicating an increase of 77% over the 1932 attack. Though the increase following the cessation of control has been a consistent one, it was not as rapid as had been anticipated.

The increase in the 1933 infestation of the Targhee was unexpected, as it had been assumed that the brood mortality which occurred on the Montana forests would extend southward into the Idaho areas. Heavy brood mortality did occur, but it was apparently not sufficiently severe to reduce the overwintering broods to a point where a reduction in the infestation followed. During the survey of the Targhee the chief of the survey party examined a total of 414* 1932-attacked trees for the presence of brood mortality. In 245, or 59% of these trees, there had been practically a complete mortality of the overwintering broods, while in the remaining 41% the emergence had been fairly normal. These data are interesting, for with this indicated 59% mortality to the insect broods a greater increase occurred than the preceding season, when no such mortality was recorded. The writer can offer but one explanation for this occurrence, which is recognized as being a deduction only. With an indicated excess mortality to the overwintering broods of 59%, one is obliged to assume that the present infestation is but 41% of what it would have been under normal

* These data must be taken as an indication of relative conditions only, for it is recognized that sufficient trees were not examined nor was the examination intensive enough for final conclusions to be drawn.

conditions. Following this premise, there would have been some 739,492 trees attacked in 1933 instead of the 303,133 now recorded. Regardless of this assumed reduction, there can be no doubt but that a serious situation still exists, which constitutes not only a real potential threat to all of the lodgepole pine stands of the forest but to the adjacent areas as well. Though this infestation is scattered throughout the entire northern portion of the forest, the heaviest concentrations are to be found to the north and east of Ashton. In this heavily infested area there are some 336,144 acres, with an infestation of .759 trees per acre, or a total of 255,232 trees.

Teton National Forest

Year	:	Infested	:	Number	:
of	Acres	trees	:	infested	:
attack	infested	per acre	:	trees	Remarks
1928	:	:	:	651	Treated spring 1929
1929	4,000	1.128	:	4,515	Treated spring 1930
1930	4,500	1.053	:	4,762	Treated spring 1931
1931	4,500	.325	:	1,461	Treated spring 1932
1932	4,500	.061	:	230	:
1933	4,500	.150	:	585	:
New area - Adjacent 1931					
1933	9,577	.967	:	9,263	burn - NE corner forest

Control measures were first instituted on the Mosquito Creek area of this forest in 1929, and continued until the fall of 1932. A substantial reduction in the infestation followed the 1931 operation, which included all portions of the area. A further reduction followed

the clean-up in 1932, but the 1933 survey data show an increase of 154%.

The 1933 survey also revealed the presence of a rather severe outbreak in the northeast portion of the forest, adjacent to the 1931 Pacific Creek fire. This outbreak is reported to cover 9,577 acres of lodgepole pine, with an infestation of 9,263 newly attacked trees. The report on this situation is not quite clear, and it is possible that a much larger acreage may be included with a correspondingly larger number of trees. The source of this heretofore unreported outbreak is unknown. The fire scorched timber could have been sufficiently attractive to have resulted in a concentration of beetles to the immediate vicinity from other areas, or it could have originated from some whitebark pine infestations which are reported as being adjacent. It is well to view this situation with alarm, for one may be assured that it directly threatens the lodgepole pine stands of the immediate vicinity.

Grand Teton National Park

Year	:	Infested	:	Number	:
of	:	acres	:	of trees	:
attack	:	infested	:	per acre	:
	:		:		Remarks
1931	:	:	:	283	Treated spring 1932. Jenny's Lake. Light attacks. (Treated spring 1933. W.B.pine.
1932	:	:	:	281	(Glacier & Death Canyon areas. Treated fall 1933. W.B.pine.
1933	:	:	:	75	Glacier, Death Canyon, Cascade areas.
1933	:	6,000	:	.35	: 1,500 : Lodgepole pine. Windy Pt area.

In 1931 a rather thorough survey was made of all the lodgepole

pine stands of the Park. A few lightly infested trees were found in the immediate vicinity of Jenny's Lake, but no new attacks were recorded from the heavy timber stands in the southern portion of the Park known as "Windy Point". Control measures instituted in 1931 for the treatment of the Jenny's Lake infestation were apparently successful, as no new attacks were recorded in the lodgepole pine stands. However, this survey did reveal the presence of mountain pine beetle outbreaks in the whitebark pine stand along the newly constructed Glacier Lake and Death Canyon Trails. Control measures were instituted in these whitebark pine areas in the spring of 1933, with subsequent maintenance control in the fall, which included the Cascade Creek drainage, through which a trail had also recently been constructed. Though these projects were instituted for the protection of the scenic timber stands along the trails, information was also desired as to the feasibility of treating these spots of whitebark pine infestation as individual control units. At the present time it would appear that such areas can be regarded as individual control units, as a reduction of 75% was secured in the Glacier Trail area and 71% in Death Canyon.

The lodgepole pine stands were again covered by a strip survey during August 1933, and though for the past two seasons no newly infested trees had been recorded, a rather serious infestation was found to be present in the Windy Point area. The almost complete absence of red-tops (1932 attacks) recorded during the 1933 survey supports the negative data previously secured. It is difficult to explain the presence of

the 1933 infestation, other than from flights of insects into the areas. However, regardless of its source, a serious situation now exists which endangers the scenic forests of the Park.

Wyoming National Forest

Year	:	Infested	:	Number	:
of	:	Acres	:	trees	:
attack	:	infested	:	per acre	:
	:		:	trees	:
	:		:		Remarks
<u>Grey's River</u>					
1928	:		:	6,945	: Treated 1929
1929	:	60,800	:	.282	: 17,160 : Treated 1930
					(2,065 treated fall 1930
1930	:	106,022	:	.162	: 17,277 : (15,222 treated spring 1931
1931	:	24,690	:	.134	: 3,325 : Treated fall 1931
1932	:	10,630	:	.275	: 2,928 : Treated spring 1931
1933	:	8,959	:	.371	: 3,324 :
<u>Green River</u>					
1932	:	500?	:	2,156	: 1,078 : Treated fall 1932. Data as to acreage uncertain.
1933	:	?	:		: 1,413 : Data incomplete.

Following the treatment of the 1930 infestation there was a substantial reduction in the infested acreage and number of infested trees. Since that time a further reduction in the acreage treated has followed the continuation of control, but the number of trees to be treated remained about the same. This persistent reinfestation has been a source of much conjecture. Infested trees which have been improperly treated or missed entirely, unknown spots of infestation, and the emerging of new adults prior to treatment have all been offered in solution. Though undoubtedly these factors have all contributed

their share, they do not seem to offer a complete answer, as the efficient control work conducted automatically minimizes their importance. The only other explanation which seems possible is from flights of insects, and it is believed that the mountain pine beetle infestation in the whitebark pine stand around the rim of the Grey's River drainage constitutes a real menace to the success of control within this area. A positive decision on this question is difficult, ~~as~~ due to the inconsistency of available data relative to the interchange of the mountain pine beetle between whitebark pine and lodgepole. In the Yellowstone rather severe infestations exist in the whitebark pine areas, which apparently have not, as yet, spread to any great extent into the lodgepole stands adjacent. In other areas this has not been the case, and control measures have been instituted to prevent such an interchange of hosts. The writer believes that when both hosts are available the whitebark pine is preferred, but when a shortage of this material occurs the lodgepole pine is attacked. The 1933 survey records the presence of 2,740 infested whitebark pine around the rim of this drainage, which may require treatment before the lodgepole pine infestation can be successfully controlled.

Though the Green River drainage had been under observation since the start of the Grey's River project, it was not thoroughly surveyed until 1932. This survey disclosed the presence of an infestation distributed throughout the area, with the heaviest concentration in the Fremont, or Pinosdale, district, where 1,073 trees were treated in the fall of 1932 on a rather small area of 500 acres. Data from the 1933 survey show a heavier infestation distributed throughout

Following the treatment of the 1929 infestation, a sharp decrease occurred in the intensity of the outbreak, though the infested acreage increased rather steadily, which was no doubt due to lack of information as to the location of infested areas. The increase in the infestation which was expected to follow the cessation of control work in 1931 did not occur; however, the infested acreage did increase until in 1933 some 40,090 acres were reported as carrying an infestation of sufficient intensity to warrant control. There have been no marked changes in the volume of the infestation on this forest until the 1933 infestation, which increased 192% and covered a 15% larger area. The 1933 situation is an alarming one, as it constitutes a real menace to both the timber stands of the Caribou and adjacent forests.

Cache National Forest

Year	:	Infested	:	Number	:
of	:	Acreage	:	trees	:
attack	:	infested	:	per acre	:
:	:	:	:	trees	:
:	:	:	:	:	Remarks
1928	:	:	:	7,906	Treated spring 1929 (2,605 treated fall 1929)
1929	:	27,419	:	.625	17,156 : (14,553 treated spring 1930)
1930	:	34,000	:	.269	9,150 : Treated spring 1931 (536 treated fall 1931)
1931	:	35,458	:	.164	5,837 : (5,251 treated spring 1932)
1932	:	17,266	:	.041	717 : Treated fall 1932
1933	:	14,311	:	.140	2,015 :

From the above data it is rather apparent that the continuous control operation on this forest has resulted in keeping the infestation at a low ebb, as well as reducing the amount of the infested acreage. The 1933 infestation indicates a sharp increase over the 1932; however, the intensity is still very low.

Yellowstone National Park

Year	: Acres	: Infested : trees	: Number : infested :	Remarks
of attack :	infested :	per acre :	trees :	
1930 :	12,344 :	.233 :	2,838 :	Trees treated spring 1931. Bechler River control unit.
1931 :	117,926 :	.373 :	43,999 :	General survey of entire park
1932 :	117,826 :	.344 :	40,590 :	" " " " "
1933 :	202,113 :	.301 :	61,005 :	

In 1931 control measures instituted in the southwest corner of the Park were apparently very successful in reducing a light infestation to a still lower status, or at least there has been no alarming reinfestation of this area reported. This result is difficult to understand, as the Targhee areas a few miles away have been subjected to a constant reinfestation. This can not be credited to the difference in the thoroughness of control work, as none existed, but perhaps the thought that there have been no flights of beetles into this small unit might be acceptable, or a possible difference in the character of the trees might have had some influence.

The first general survey of the Park was made in 1931, which has been repeated during the past two seasons. An aerial reconnaissance of the Park was made in July 1931, and repeated in 1933, for the purpose of locating all groups of red tops so as to more efficiently plan the subsequent ground surveys. As a result of the 1933 reconnaissance a number of new areas were added to the territory to be surveyed.

The Yellowstone situation is a peculiar and puzzling one. For the past three seasons the infestation has remained at approximately

the same degree of intensity, though in 1933 some 84,287 acres, supporting an infestation of 27,980 newly attacked trees, were added to the total area surveyed. The infestation on these new areas averaged .331 trees per acre, which is comparable with the general situation throughout the Park. Data from the 1933 survey indicate that 13% of the infested trees are lodgepole, with the bulk of the infestation being in the whitebark pine stands at the higher elevations. Furthermore, 33% of the lodgepole pine infestation is in the Bechler district, a portion of which was treated in 1931. The remainder of the lodgepole infestation is scattered throughout the different units as single trees and some small groups.

In most of the whitebark pine areas one can find evidence of old mountain pine beetle work, with some few black tops of a more recent attack, and an assumption that the insects have been present within these areas for years is no doubt correct. This assumption, together with the fact that during the past two seasons the infestation has been reported as being practically confined to whitebark pine, prompted the thought that the insects might remain in these areas and not endanger the lodgepole stands adjacent. However, the insects have not been present in these areas in such numbers as are now present, nor has an outbreak of equal magnitude occurred in the history of the present timber stand. Any evidence of such an occurrence is lacking, so no assurance can be given that these insects will remain in whitebark pine.

It is assumed that the present infestation or outbreak within the Park started some four or five years ago, as groups of red-tops

began to appear in many of the whitebark pine areas in 1930. Since that time the infestation has increased in severity, and other areas have become infested. At the existing rate of depletion the available host material in many of these whitebark pine areas will only last for a few years more, and then, if not before, will the insects be obliged to turn to other hosts for existence. It is difficult to foresee the future of this infestation, though at this time the writer is very much of the opinion that the outbreaks in whitebark pine constitute a real menace to the future of the lodgepole pine stands of the area. The data from this year's survey show an increase in the number of infested lodgepole pine, which though not alarming at this time, constitutes a real warning of what the future may hold in store.

SUMMARY TABLE OF INVESTED ACRES AND NUMBER OF ATTACKED TREES FOR PAST FOUR YEARS

Name of Forest	1950		1951		1952		1953	
	Acres	Infestation : Trees	Acres	Infestation : Trees	Acres	Infestation : Trees	Acres	Infestation : Trees
Beaverhead	1,341,000	5,935,053	1,341,000	15,002,580	1,341,000	17,536,171	1,341,000	915,937
Old Madison	13,800	2,835	45,700	6,976	45,700	10,317	45,700	7,504
Shoop Canyon	2,345	3,045	23,000	23,103	23,000	151,000	23,000	14,058
Callahan	--	--	62,720	9,576	114,000	17,335	141,440	18,956
Targhee	102,970	55,007	400,427	119,574	404,597	170,002	404,294	303,189
Teton	46,000	4,702	45,000	1,441	45,000	290	4,500	595
Wyoming	106,022	17,100	24,600	5,325	10,600	2,228	9,400	4,737
Caribou	14,900	11,559	24,000	11,245	54,520	13,756	40,000	65,022
Cascade	34,000	9,150	35,453	5,537	17,236	717	14,311	2,015
Yellowstone Park	12,544	2,806	117,926	45,909	117,926	40,590	202,113	61,005
Teton Park	--	--	--	255	--	201	6,000	1,500
Grand Total	1,673,510	8,923,514	2,201,451	15,020,376	2,240,119	12,008,235	2,238,517	1,392,967

Of the total 1953 infestation, there are 430,052 trees, or an area of 740,000 acres, which would need be considered in any plans of control for this project.

THE 1933 SITUATION

As one compares the 1933 situation with that of 1931, a condition which resulted in the cessation of control on the Yellowstone and Targhee, it is difficult to see where an improvement has followed the so-called "break" in the infestation. It is true that following this "break" the Beaverhead infestation dropped from 17,586,176 infested trees in 1932 to 915,597 in 1933, which is a decrease of 95%. Decreases of 90 and 61 percent also occurred in the Sheep Canyon and old Madison Forest, while the infestation on the Gallatin increased 5 percent. The 77% increase in the Targhee infestation was unforeseen, as the winter mortality to the overwintering bark-beetle broods was expected to be sufficiently severe to result in a marked reduction. The Yellowstone infestation remained about the same as in 1932, though an increased acreage was added to the infested area. New outbreaks requiring the institution of control were reported from the Teton National Forest and Grand Teton National Park. The Grey's River infestation on the Wyoming Forest remained at about the same level as in 1932, while the Caribou Forest adjacent showed a decided increase in the number of infested trees. Control measures have been continuous on the Cache, with about the same reduction following the treating of the 1932 infestation as in previous seasons.

This variety of conditions which exists on the different forests, with an apparent decreased effect of winter kill in the southern units, must not be taken as a measurement of the percent of brood

mortality resulting from the low temperatures of the past winter. If it were possible to compute the status of the 1933 infestation with no abnormal mortality, then it could be said that the difference between such an intangible figure and the present status of the infestation would represent fairly accurately the reduction in the volume of infestation resulting from winter kill. That this effectiveness varied for the different units, and in the units themselves, is evident. An outstanding example of this variation can be seen in the data from the Beaverhead and Gallatin National Forests, where with an estimated brood mortality of 90% on both forests a reduction in the infestation of 95% occurred on the Beaverhead and an increase of 5% on the Gallatin. Different explanations might be offered for such an occurrence, but ^{as} at this time they would be but assumptions they have been omitted from this discussion.

The benefits to be derived from winter kill are somewhat uncertain. If in the destruction of a certain percent of the overwintering broods of the mountain pine beetle the parasites and predators are not destroyed, then it is possible that a permanent reduction of the outbreak may follow. As there is a greater concentration of these beneficial insects in the heavily infested areas, the different types of infestation would also show different results. If the parasites and predators are destroyed in equal proportion to the bark-beetle broods, such an abnormal mortality would only reduce the volume of the outbreak but cause no reduction

in the potential strength, and with host material available the infestation would undoubtedly rebuild to its former severity.

To correlate the benefits of winter kill with the institution of artificial control is likewise difficult. Obviously, to benefit from the effects of winter kill one would hesitate to institute control against a generation of insects which had been largely destroyed, as practically every tree would need to be treated. On the other hand, if this mortality were uniform and the broods had been destroyed in the upper portion of all trees, or above snow line, the institution of control would perhaps be advisable, as only the base of the trees would require treatment. Control should also be directed against partially destroyed broods, where the mortality has not been sufficiently severe to result in a reduction of the infestation.

Regardless of the foregoing discussion, we are faced with a situation where the effects of winter kill, on the units where control measures are necessary, have resulted in no appreciable change in the status of the infestation over previous seasons. One can correctly assume that the 1933 infestation on the Targhee was materially reduced as a result of this abnormal mortality, and it is possible that the same condition exists on the units to the south. Though on several of the project units the present situation is of a more serious character than at the time work was discontinued in 1931, the entire project can be viewed in a more favorable light. The Yellowstone project was discontinued on the grounds that regardless

of how thoroughly the infestation on the different units might be treated an annual reinfestation would occur from the more heavily infested areas to the north and east. As this has a direct bearing upon the plans for future comparable situations it is unfortunate that the soundness of this analysis can not be clarified. However, the so-called "break" in the infestation has been of value, as it is possible that this potential source of reinfestation has been eliminated. The outbreaks on the western portion of the Salmon and the Challis National Forests of Idaho seem to have subsided to a point where there should be no further danger of reinfestation from this source, and it is hoped that the marked reduction in the Beaverhead infestation will be maintained by natural enemies. Though it is possible that these outbreaks may rebuild into serious situations in the future, this is not expected to occur; however, this reaction is but a belief, with no supporting data whatever. If one can accept an assumption that the source of reinfestation has been eliminated, or at least minimized, then the success of control within the Targhee and Yellowstone should depend upon the efficiency of the work as conducted within the areas themselves.

To summarize briefly, it would seem that the benefits of the so-called "break", though undoubtedly present within the different control units of the Yellowstone project, are intangible. However, appreciable benefits do lie in the possible elimination of the potential sources of reinfestation, a condition which resulted in the cessation of control in the fall of 1931, and would now seem to make the reopening of this project a feasible undertaking.

RECOMMENDATIONS

If the present status of the mountain pine beetle infestation in the lodgepole pine stands of the different units of the Yellowstone project is studied, with the memory of the devastation which has occurred on the Beaverhead and central Idaho forests, the seriousness of the situation is more fully appreciated. Since the cessation of control in the spring of 1931, the Targhee infestation has developed to a degree which during the next few years will increase rapidly and unless checked by natural or artificial means will destroy not only the timber stands of the Targhee but adjacent forests as well. Though the economic importance of this situation can be appreciated, it is difficult to evaluate. Commercial timber stands can be appraised, but the scenic values of the forests which are at stake are difficult to weigh. What effect such an epidemic will have upon the timber stands in question is difficult to depict, and reference can only be made to the devastation which has occurred on the Montana and central Idaho forests, where on large areas 75% of all trees of 6" or more in diameter have been killed.

In studying the entomological aspects of this situation, there are no reasons to assume that success should not follow the institution of artificial control, and the following recommendations are based upon the entomological phases of the problem only. Though the present situation has been described in some detail, with a brief attempt at forecasting future depredations, it would seem that the final decision as to the economics

of the expenditures recommended should rest upon the agency charged with the responsibility of the timber lands in question.

In view of the seriousness of the present situation, as well as the rather evident fact that if control is not instituted on the Targhee in the spring of 1934 it will no longer be feasible, it is recommended that the Yellowstone project be reopened in the spring of 1934. In reopening this project it is recommended that the infested portion of all units be covered with as thorough a clean-up as possible. The Yellowstone problem is a difficult one to correctly analyze. It is possible that our activities should be directed toward the infestation in lodgepole pine only, with no attention being paid to the outbreak in whitebark pine, though the writer sincerely believes that an interchange of these hosts is inevitable. If this occurs, it would be a simpler operation to cover the rather small areas now infested than the large bodies of lodgepole once a spread has occurred. It is therefore recommended that the most accessible areas and those adjacent to the susceptible lodgepole pine forests be included in this project.

The following requests for funds have been made by the Forest Service and Park Service, to which I concur, with the listed reservations:

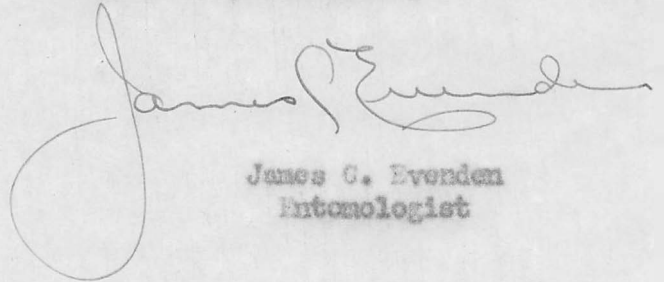
<u>Unit</u>	<u>Funds Requested</u>	<u>Writer's Comments</u>
Yellowstone	\$125,000	This amount will not be sufficient to cover the areas where control is necessary. Would suggest \$180,000, as the cost of treatment in these remote areas will be at least \$3.00 per tree.

<u>Unit</u>	<u>Funds Requested</u>	<u>Writer's Comments</u> (Cont.)
Targhee	\$300,000	Would suggest an additional \$25,000.
Caribou	63,000	Should be sufficient.
Cache	4,000	Should be sufficient.
Wyoming	15,000	Would suggest an additional \$6,000 to treat the adjacent whitebark pine infestation.
Teton	15,000	Would suggest an additional \$5,000 to effect a good clean-up of the newly infested area near the 1931 Gravel Creek fire.

To this total of \$512,000 which has been estimated as being necessary for the treatment of all the project units, the writer would recommend the allotment of an additional \$91,000. This recommendation does not take into consideration any IMPHRA funds which have been previously allotted to Region Four. It is recognized that this is a large appropriation, and it is possible that even in the event of the writer's recommendations being accepted sufficient funds will not be available. If any reduction in this allotment is to be made, it is recommended that the work in the Yellowstone unit be restricted to the lodgepole infestation in the Bechler area, which would necessitate an expenditure of some \$5,000 instead of \$180,000 as estimated, though this is recommended. The reason for this position is that there is a question as to the infestation in the whitebark pine stands spreading into the lodgepole. However, there would seem to be no other possible separation of the remaining units, as the infestation is so closely connected that areas left untreated

will seriously affect the results of control on the others, and eventually cost far more for control than the original estimate. A further reduction in the allotment of funds for the institution of control within these forests will prove to be false economy.

Respectfully submitted,

A handwritten signature in cursive script, reading "James C. Evenden". The signature is written in dark ink and is positioned above the printed name and title.

James C. Evenden
Entomologist

